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Song et al.

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(54) **LPG BOMB APPARATUS**

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F17C 7/04 (2006.01)

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USPC 137/565.17, 583, 588, 589, 512; 417/244, 250, 251, 252, 253, 286, 300, 417/307; 62/45.1; 123/27, 525–259
See application file for complete search history.

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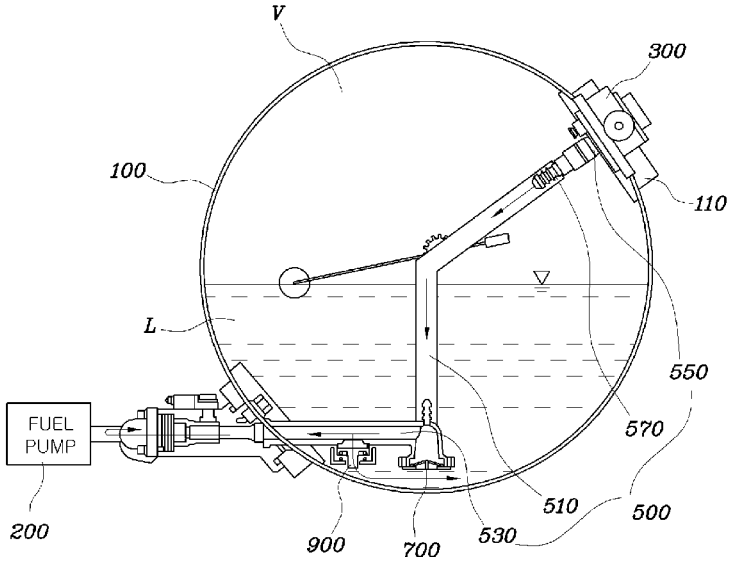
(57) **ABSTRACT**

An LPG bomb apparatus is provided, including: a fuel charging unit formed on a LPG bomb; a fuel conduit through which fuel flows from the fuel charging unit to a fuel pump; a first check valve that is formed on the fuel conduit inside the LPG bomb and sucks the fuel with a pressure of the fuel pump; and a second check valve that is formed on the fuel conduit inside the LPG bomb, is spaced apart from the first check valve, and discharges the fuel to be charged by the fuel charging unit to the LPG bomb.

11 Claims, 8 Drawing Sheets



(52) **U.S. Cl.**
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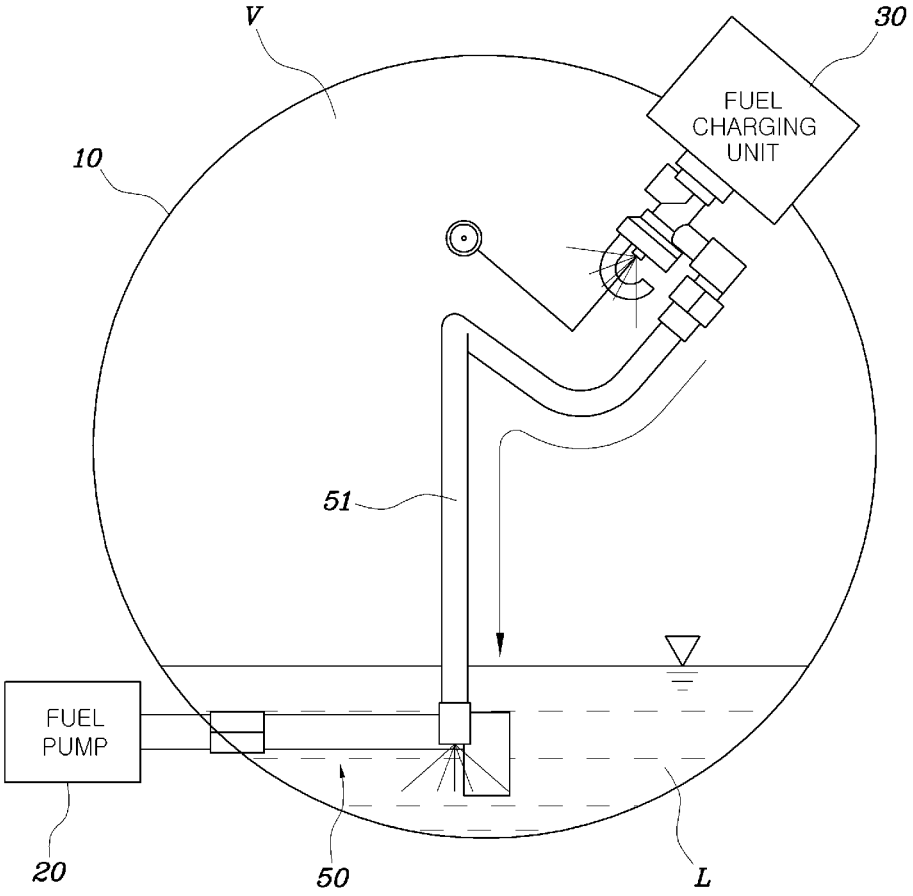

FIG. 1 (RELATED ART)

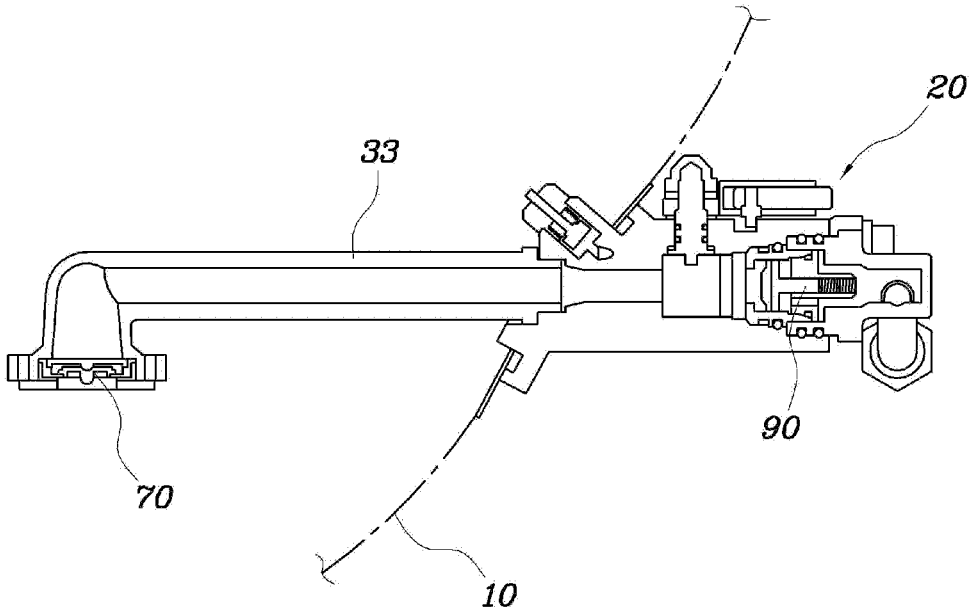

FIG. 2 (RELATED ART)

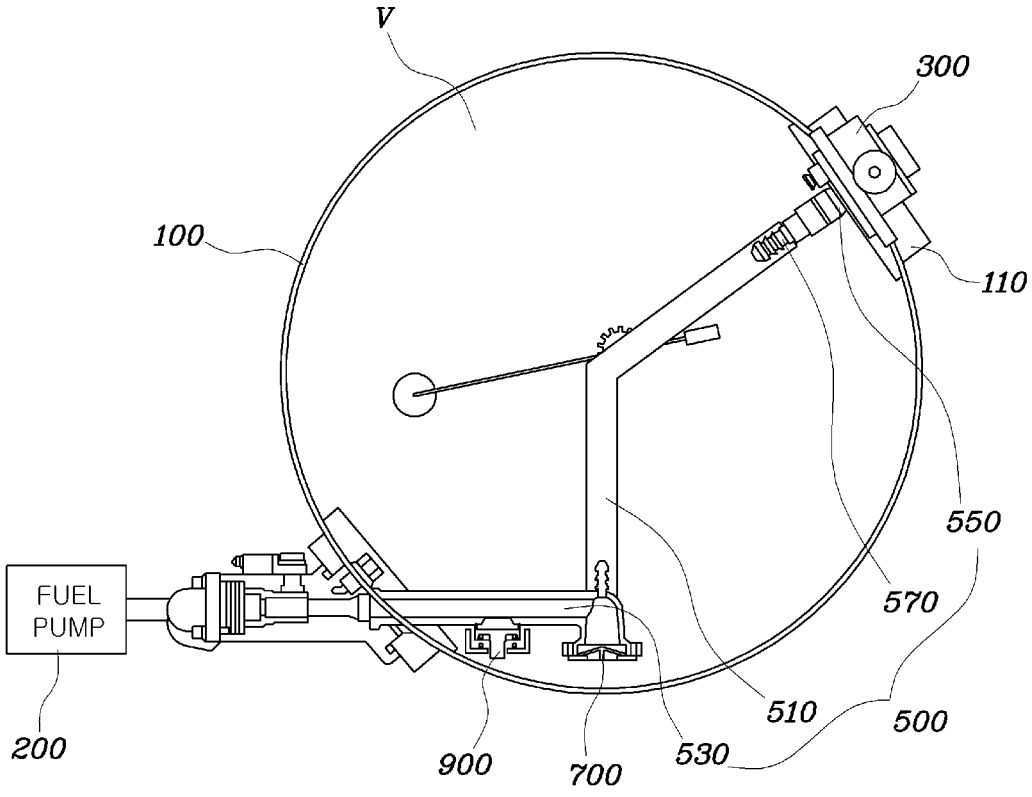

FIG. 3

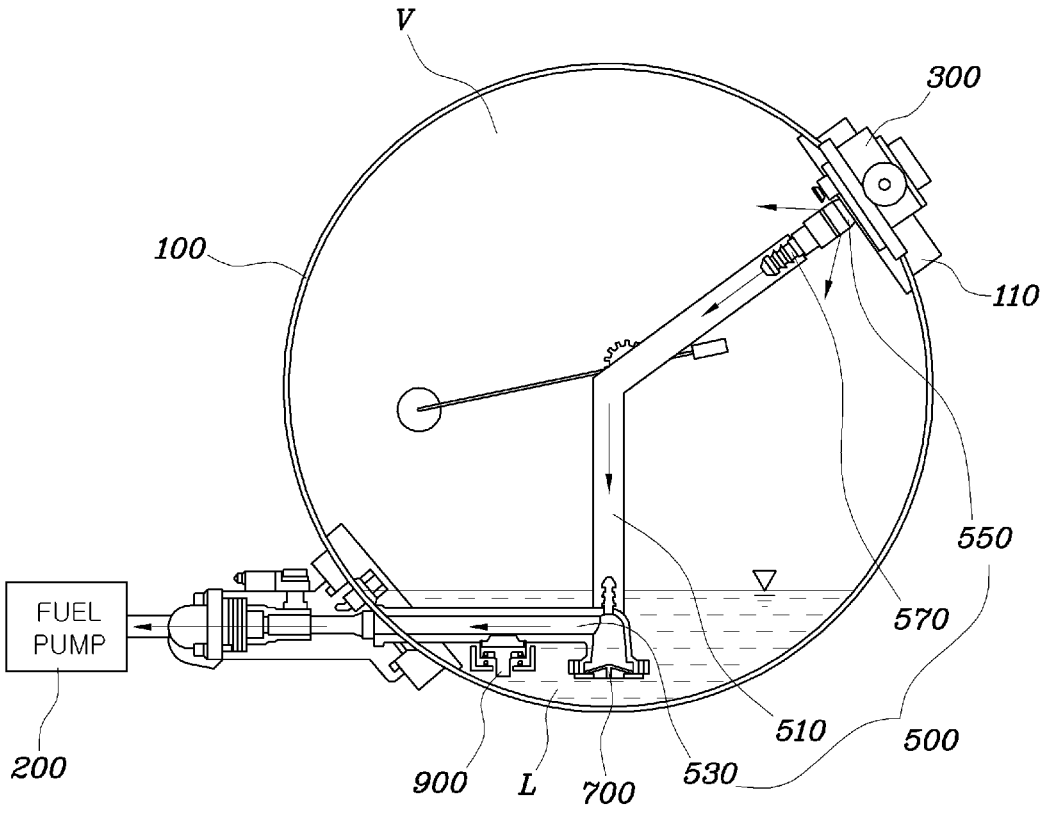

FIG. 4

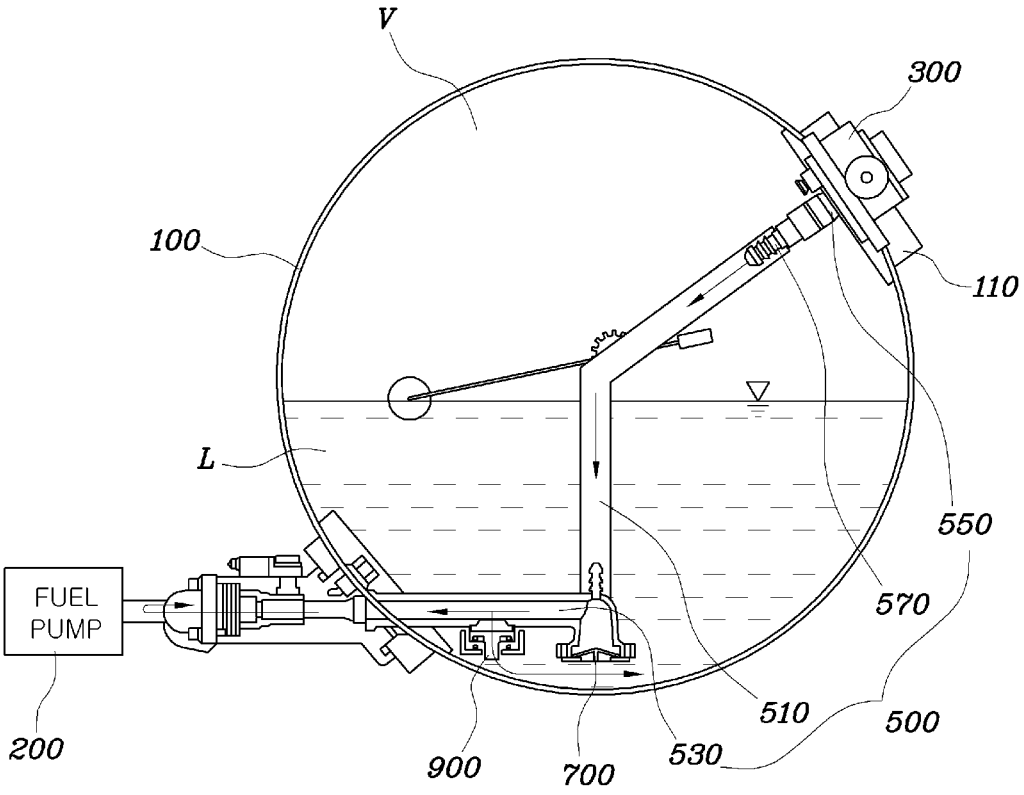

FIG. 5

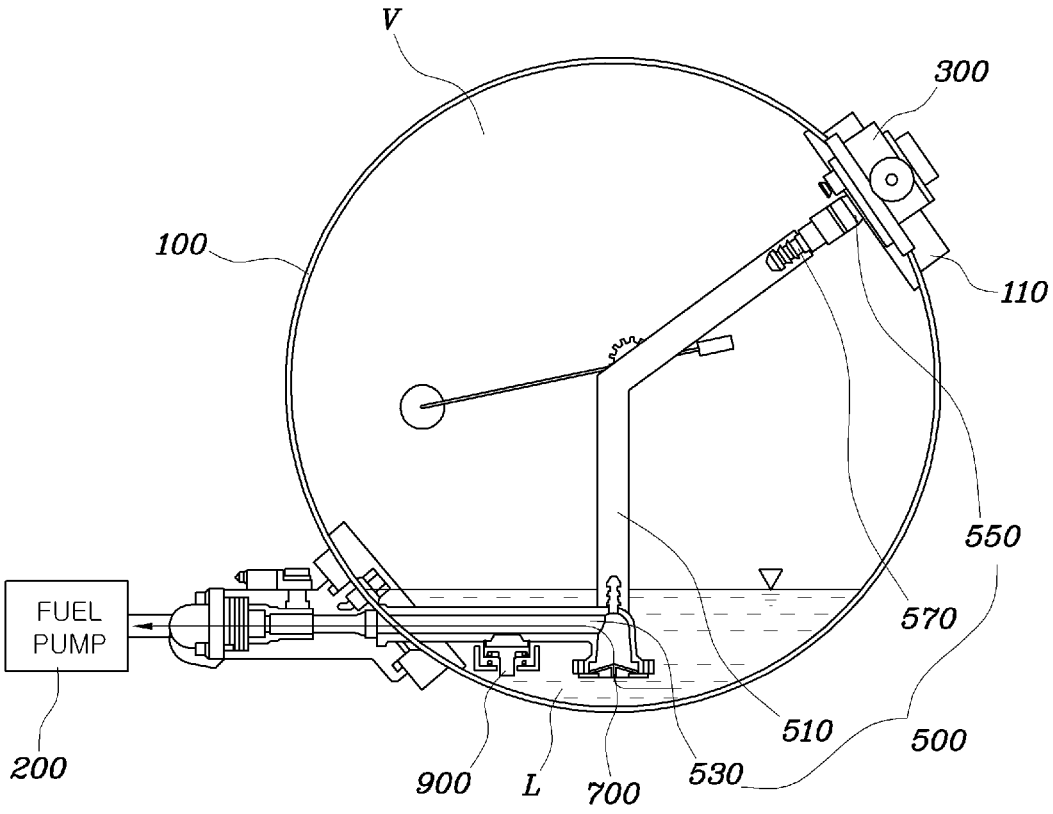

FIG. 6

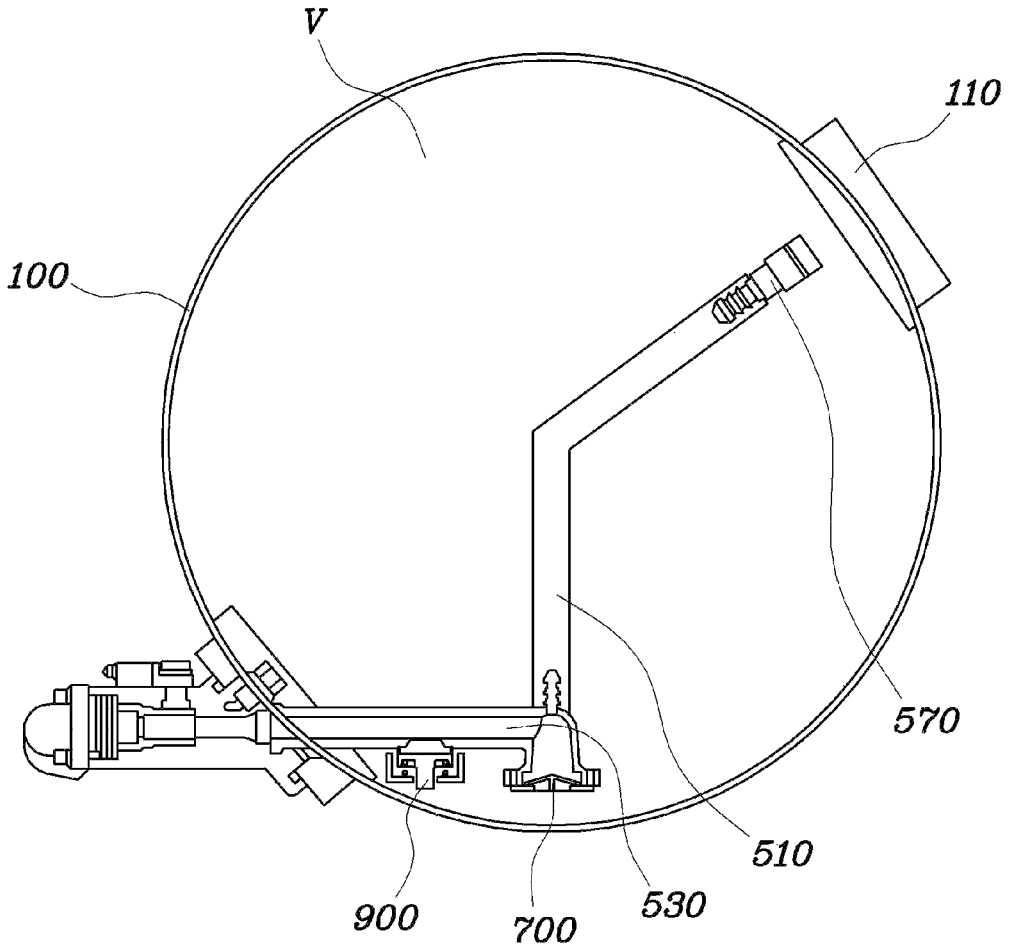

FIG. 7

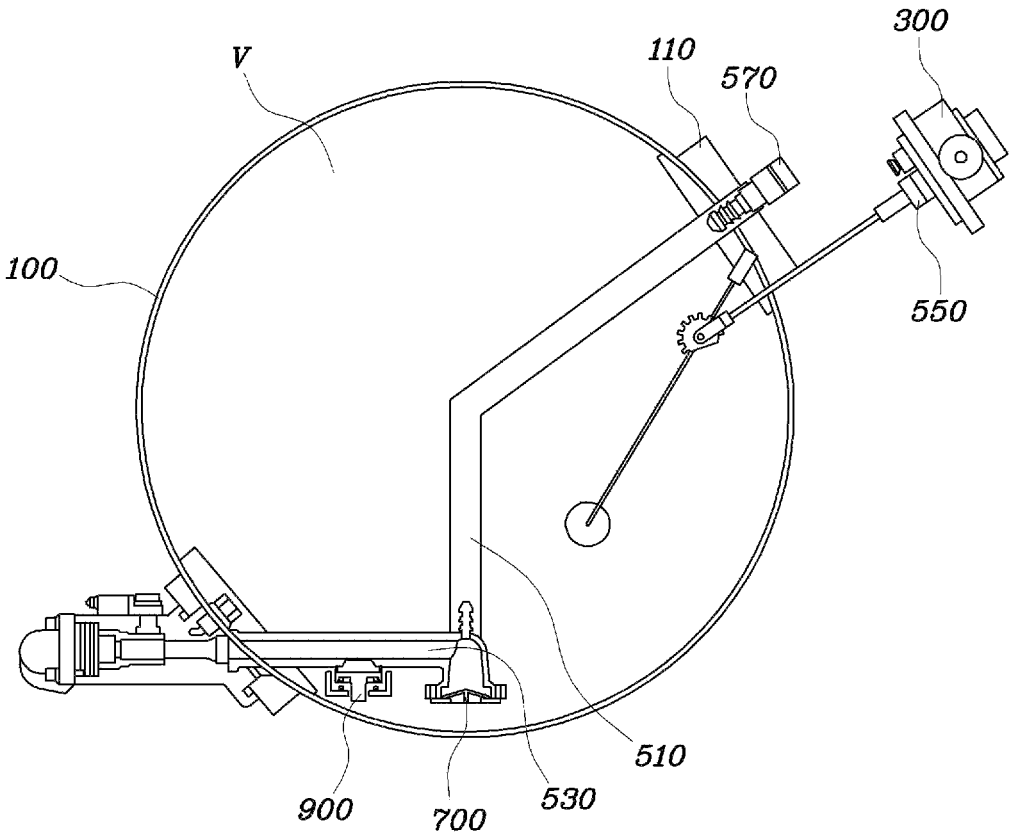

FIG. 8

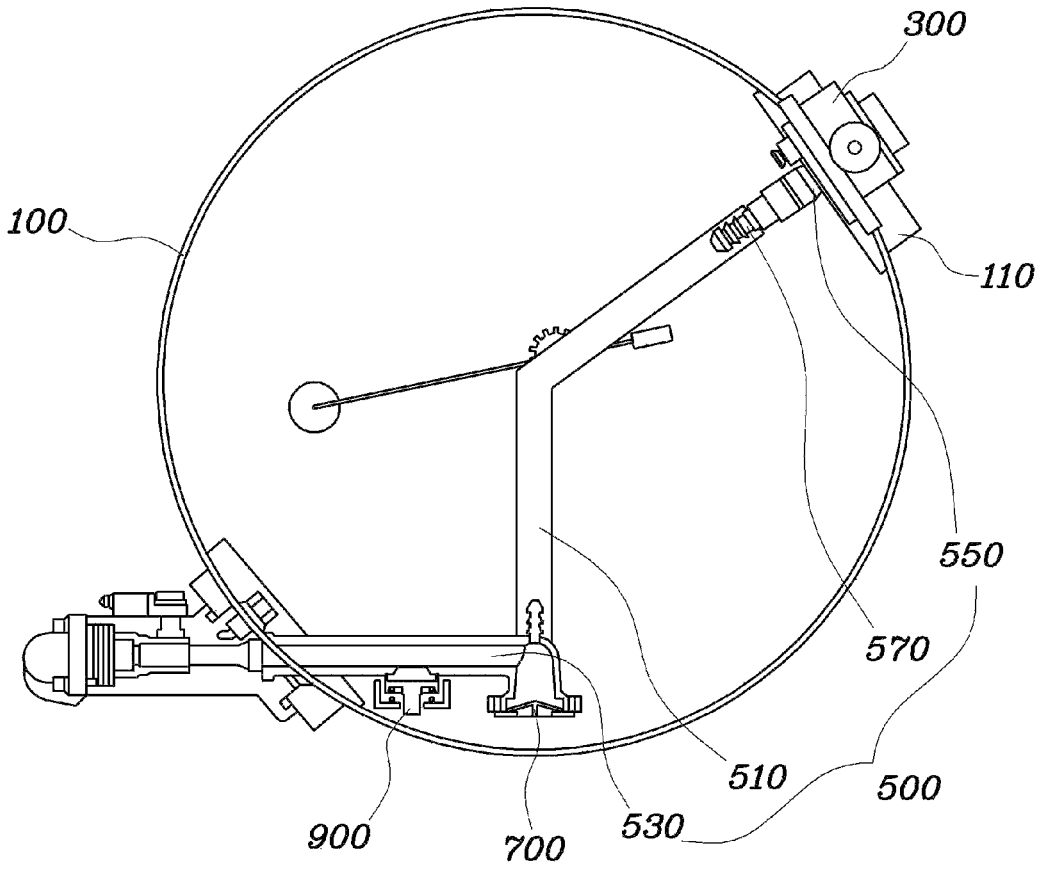

FIG. 9

LPG BOMB APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims under 35 U.S.C. §119(a) the benefit of Korean Patent Application No. 10-2012-0153735 filed Dec. 26, 2012, the entire contents of which are incorporated herein by reference.

BACKGROUND

(a) Technical Field

The present disclosure relates to a fuel tank of a vehicle using LPG (Liquefied Petroleum Gas) as a fuel. More particularly, it relates to a LPG bomb apparatus capable of maintaining a constant pressure therein.

(b) Description of the Related Art

In existing LPG vehicles using LPG as a fuel, the LPG is evaporated and then supplied to the engines of the vehicles. However, a LPI (Liquefied Petroleum Injection) arrangement in which LPG is directly injected as a high-pressure liquid-phase by an injector has been mainly used in order to solve a problem such as a poor start-up during cold weather, for example, in winter time.

In a conventional arrangement, a fuel pump may lose its suction capability due to cavitations generated when temperature, pressure or composition of fuel within the LPG bomb are varied abruptly in the course of recharging LPG.

In a related art, Korean Application No. 10-2010-0097570, in order to solve the above-mentioned problem, discloses that a fuel is charged through a liquid-phase outlet formed on the front end of a charging pipe and a gas-phase outlet formed on an upper part of the charging pipe concurrently to maintain constantly a gas-phase side pressure in the LPG bomb and to prevent a charge delaying phenomenon caused by a pressure increase in the gas phase side.

FIG. **1** is a view showing a LPG bomb apparatus according to the related art in which a part of fuel injected through a fuel charging unit **30** is evaporated and is charged to a gas-phase side V, and another part of fuel is charged to a liquid-phase side L via a liquid-phase charging pipe **51**. The fuel in the liquid-phase side L is sucked by a fuel pump **20**.

FIG. **2** is a view showing a LPG bomb apparatus according to a related art in which a first check valve **70** and a second check valve **90** are formed on a charging conduit **33** of a LPG bomb **10** and suck fuel to a fuel pump. The first check valve **70** is formed on the front side of a suction conduit and the second check valve **90** is formed on a side of a fuel motor **20**.

Generally there is no problem in vehicles that are fully charged and then restarted after automatically cutting-off the charging, while a pressure in a LPG bomb is increased again after the pressure in the LPG bomb was decreased. However, in cases in which the vehicles are charged frequently with small quantities of LPG and driven at low speeds repeatedly to increase temperature in the LPG bomb, start-up of the vehicles may be impossible if it is attempted to re-start the vehicles at the moment when the pressure in the LPG bomb is decreased during charging.

Due to this, the pressure before start-up of the vehicle is maintained even though the pressure in the LPG bomb is decreased by a check valve used in an ordinary suction pipe conduit during charging, and after start-up, heat remains in the fuel pump to form high pressure in the suction pipe conduit when compared with the LPG bomb.

Therefore, when trying to restart the vehicles after charging, it is impossible to restart the vehicles because the pressure in the LPG bomb is formed lower than the pressure in the suction pipe conduit and thus the fuel within the LPG bomb is not inflowed smoothly into the suction pipe.

Thus, there is a need for an apparatus which can improve poor start-up performance after charging even when a vehicle is frequently charged with LPG by small quantities of fuel and is restarted after charging, by allowing a fuel temperature in a LPG bomb preferably to be maintained, and thus not decreased.

The disclosure in the background art is only to assist to understand of the background of the present invention, but it is not understood that the disclosure is a prior art known to those skilled in the art.

SUMMARY

The present invention has been made in an effort to solve the above-described problems associated with the related art. An object of the present invention is to provide a LPG bomb apparatus, capable of improving a poor start-up performance after charging even when a vehicle is frequently charged with LPG by small quantities of fuel and is restarted after charging, by allowing a fuel temperature in a LPG bomb not to be decreased.

In order to achieve the above object, the LPG bomb apparatus according to the present invention may include: a fuel charging unit formed on a LPG bomb; a fuel conduit through which fuel flows from the charging unit to a fuel pump; a first check valve that is formed on the fuel conduit inside the LPG bomb and sucks the fuel with a pressure of the fuel pump; and a second check valve that is formed on the fuel conduit inside the LPG bomb, is spaced apart from the first check valve, and discharges the fuel to be charged by the fuel charging unit to the LPG bomb.

The fuel conduit may include: a liquid-phase charging pipe an upper end of which is connected to the fuel charging unit and a lower end of which is extended to a bottom of the LPG bomb; and a suction conduit that is connected to the liquid-phase charging pipe and transports the sucked fuel to the fuel pump.

The liquid-phase charging pipe may be made of a flexible material.

The liquid-phase charging pipe may be a plastic tube.

The first check valve and the second check valve may be formed on the suction conduit.

The first check valve and the second check valve may be formed on a downstream side of the suction conduit.

An injection hole preferably is formed on the upper end of the fuel conduit to evaporate a part of the fuel in accordance with a ratio determined when charging the fuel and to inject the evaporated fuel to a gas-phase side V of the LPG bomb.

The first check valve may have an umbrella shape, and a fuel suction capability thereof may be not affected by the pressure that opens the valve.

The first check valve may be opened while a vehicle drives and the fuel inflows into the fuel pump therethrough.

The second check valve may be opened to charge a liquid-phase side L of the LPG bomb with the fuel when a pressure generated in the fuel conduit is a set pressure or more when charging the fuel.

A quick connector may be formed on the upper end of the fuel conduit to facilitate the assembling of the fuel conduit and the fuel charging unit.

It is understood that the term "vehicle" or "vehicular" or other similar term as used herein is inclusive of motor vehicles in general such as passenger automobiles including sports utility vehicles (SUV), buses, trucks, various commer-

cial vehicles, watercraft including a variety of boats and ships, aircraft, and the like, and includes hybrid vehicles, electric vehicles, plug-in hybrid electric vehicles, hydrogen-powered vehicles and other alternative fuel vehicles (e.g. fuels derived from resources other than petroleum). As referred to herein, a hybrid vehicle is a vehicle that has two or more sources of power, for example both gasoline-powered and electric-powered vehicles.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features of the present invention will now be described in detail with reference to certain exemplary embodiments thereof illustrated the accompanying drawings which are given hereinbelow by way of illustration only, and thus are not limitative of the present invention, and wherein:

FIG. **1** (RELATED ART) is a view showing a LPG bomb apparatus according to a related art;

FIG. **2** (RELATED ART) is a view showing in detail a suction conduit of a LPG bomb apparatus according to a related art;

FIG. **3** is a view showing a LPG bomb apparatus in accordance with one embodiment of the present invention;

FIG. **4** is a view showing a LPG bomb apparatus when starting a charging according to the present invention;

FIG. **5** is a view showing a LPG bomb apparatus during a charging according to the present invention;

FIG. **6** is a view showing a LPG bomb apparatus during a driving according to the present invention;

FIG. **7** is a view showing a first assembling step of a LPG bomb apparatus according to the present invention;

FIG. **8** is a view showing a second assembling step of a LPG bomb apparatus according to the present invention; and

FIG. **9** is a view showing a final assembling step of a LPG bomb apparatus according to the present invention.

It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various preferred features illustrative of the basic principles of the invention.

In the figures, reference numbers refer to the same or equivalent parts of the present invention throughout the several figures of the drawing.

DETAILED DESCRIPTION

Hereinafter reference will now be made in detail to various embodiments of the present invention, examples of which are illustrated in the accompanying drawings and described below.

FIG. **3** is a view showing a LPG bomb apparatus in accordance with one embodiment of the present invention, FIGS. **4** to **6** are views showing a LPG bomb apparatus during a charging or a driving, and FIGS. **7** to **9** are views showing the assembling steps of a LPG bomb apparatus according to the present invention.

As shown in FIG. **3**, a LPG bomb apparatus according to the present invention may include: a fuel charging unit **300** provided on a LPG bomb **100**; a fuel conduit **500** through which fuel flows from the fuel charging unit **300** to a fuel pump **200**; a first check valve **700** that is formed on the fuel conduit **500** in the LPG bomb **100** and sucks the fuel by a pressure of the fuel pump **200**; and a second check valve **900** that is formed on the fuel conduit **500** in the LPG bomb **100**, spaced apart from the first check valve **700**, and discharges the fuel charged by the fuel charging unit **300** to the LPG bomb **100**.

The fuel conduit **500** may include: a liquid-phase charging pipe **510** with an upper end connected to the fuel charging unit **300** and a lower end extended to a bottom of the LPG bomb **100**; and a suction conduit **530** connected to the liquid-phase charging pipe **510** to transport the sucked fuel to the fuel pump **200**. The liquid-phase charging pipe **510** may be formed of a flexible material, such as a plastic having flexibility and preferably capable of preventing corrosion thereof when charging a fluid fuel.

The first check valve **700** and the second check valve **900** may be formed on the suction conduit **530** of the fuel conduit **500**, in particular, on a downstream side of the suction conduit **530**, and being spaced apart from each other.

In addition, an injection hole **550** may be formed on the upper end of the fuel conduit **500** to evaporate a part of the fuel and to inject the part of the evaporated fuel to a gas-phase side V of the LPG bomb **100** in accordance with a ratio determined when charging fuel, and the remaining fuel is charged to a liquid-phase side L through the liquid-phase charging pipe **510**.

Referring now to FIGS. **4** to **6**, FIG. **4** shows the interior of the LPG bomb **100** when starting a charging in which a fuel charged is evaporated and a pressure in the LPG bomb **100** is rapidly decreased while the temperature in the LPG bomb **100** is increased, when a vehicle starts-off in order to charge fuel into the LPG bomb **100**. In this case, the pressure before start-up of the vehicle may be maintained even though the pressure in the LPG bomb **100** is lowered at the time of restarting the vehicle, and even after vehicle start-up, heat still remains in the fuel pump **200** to make the pressure in the fuel pump **200** higher than that in the LPG bomb **100**, and thus to prevent the fuel from flowing into the fuel pump **200** not to restart the vehicle.

The fuel may flow in the direction of arrows depicted in FIG. **4**, when the LPG bomb **100** is charged with the fuel such that the liquefied fuel passes through the fuel conduit **500** to reach the fuel pump **200** via the fuel charging unit **300**. At this time, a part of the liquefied fuel may be evaporated through the injection hole **550** to be injected into the gas-phase side V. Generally, the amount of fuel injected to the gas-phase side V and the amount of fuel injected to the liquid-phase side L may be varied depending on a model and/or a state of different vehicles. In one embodiment according to the present invention, a case in which the ratio of the gas-phase to the liquid-phase is 5:95 will be described.

When starting to charge a fuel, a pressure may be generated in the fuel conduit **500** while pressure is not generated in the fuel pump **200**, to prevent the fuel being charged from being evaporated by high temperatures in the LPG bomb **100**. The temperature, pressure, and composition of the fuel in the LPG bomb preferably is equal to those of the fuel in the fuel conduit **500**.

When the fuel is continuously charged in the fuel conduit **500** while it is full of the fuel as depicted by the arrows in FIG. **5**, the fuel cannot flow to the fuel pump **200** to continuously produce pressure, and the second check valve **900** capable of discharging the fuel to the liquid-phase side L of the LPG bomb **100** from the suction conduit **530** is opened by the elasticity of the valve to discharge the fuel that flowed into the suction conduit **530** via the liquid-phase charging pipe **510** to the liquid-phase side L.

The second check valve **900** may be opened to charge the liquid-phase side L of the LPG bomb **100** with fuel, when the pressure generated in the fuel conduit **500** in the course of charging exceeds a predetermined pressure. The pressure for opening the second check valve **900** may be set at different levels by design choice, but preferably is set higher than that of the LPG bomb **100**.

FIG. **6** shows a flow of fuel during a driving, in which a pressure may be generated in the fuel pump **200** to suck a fuel such that the fuel is sucked to the inside of the suction conduit **530** when the pressure is generated in the fuel pump, and the second check valve may be opened when a pressure higher than the predetermined pressure is applied thereto, but it cannot be opened because a negative-pressure is generated in the suction conduit **530** from the fuel pump **200**. Moreover, the second valve preferably has a counter shape.

The first check valve **700** may be opened, and the fuel may be sucked to the suction conduit **530** from the LPG bomb **100** via the first check valve **700**. The first check valve preferably has an umbrella shape, and a fuel suction capability thereof is not affected by the pressure that opens the valve.

FIGS. **7** to **9** represent steps for assembling a LPG bomb apparatus according to one embodiment of the present invention. The fuel charging unit **300** and the fuel conduit **500** may be separately assembled to the LPG bomb **100**. In the LPG bomb apparatus according to one embodiment, assembly steps of the first check valve **700** and the second check valve **900** are depicted.

FIG. **7** shows a first step for installing the first check valve **700**. The first check valve **700** and the second check valve **900** may be formed on the suction conduit **530**, and the liquid-phase charging pipe **510** formed by a flexible plastic tube may be pressed into the second check valve **900**. Further, as shown in FIG. **7**, a quick-connector **570** may be formed on the upper portion of the liquid-phase charging pipe **510** of the fuel conduit **500** to facilitate the assembly of the fuel conduit **500** and the fuel charging unit **300**. The quick-connector **570** may set a path of the liquid-phase charging pipe **510** such that it is possible to access to the quick connector for assembling the fuel charging unit **300** through the a fuel charging unit assembling hole **110** formed on the LPG bomb **100**.

FIG. **8** shows a second step for installing the fuel charging portion **300**. The quick-connector **570** coupled to the liquid-phase charging pipe **510** may be protruded to the outside via the fuel charging unit assembling hole **100**. For example, the liquid-phase charging pipe **510** can be protruded outside since it is made of flexible material and some clearance is generated when it is pulled due to its three dimensional path. The quick-connector **570** protruded to the outside and a liquefied fuel discharging part of the fuel charging unit **300** may be coupled with each other, and then the fuel charging unit **300** may be entirely fastened to the fuel charging unit assembling hole **110** of the LPG bomb **100**.

FIG. **9** shows the completely assembled LPG bomb apparatus according to one embodiment of the present invention. In the LPG bomb apparatus according to one embodiment of the present invention, the charging of the bomb is completed when the LPG bomb is at the lowest pressure during charging at a high temperature (about 50~58° C.) while the air within the LPG bomb is substantially removed and approximately 20% of the fuel remains in the LPG bomb. According to the present invention, after completing the charging, unlike the prior art, the pressure in the LPG bomb is lowered and a liquefied fuel flows into the suction conduit during the charging, and thus the vehicle can be restarted after charging.

According to the present invention, even though a vehicle restarts after a charging while a vehicle is frequently charged with LPG by small quantities of fuel, the vehicle can be driven under severe conditions such as a low-speed overload state, or the internal temperature of the LPG bomb can be increased in a scorching summer, and the pressure in the LPG bomb will remain higher than the pressure in the suction conduit to transport fuel in the LPG bomb in a normal manner to a fuel motor, thereby improving start-up performance.

While the invention has been described in conjunction with exemplary embodiments, it will be understood that present description is not intended to limit the invention to those exemplary embodiments. On the contrary, the invention is intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A Liquefied Petroleum Gas (LPG) storage apparatus comprising:

a fuel charging unit formed on an LPG container to refill fuel into the LPG container;

a fuel conduit through which the fuel flows from the fuel charging unit to a fuel pump arranged outside of the LPG container;

a first check valve that is formed on the fuel conduit inside the LPG container and allows the fuel to flow through the fuel conduit when a pressure is generated in the fuel pump; and

a second check valve that is formed on the fuel conduit inside the LPG container, is spaced apart from the first check valve, and discharges the fuel to be charged by the fuel charging unit to the LPG container.

2. The LPG storage apparatus according to claim **1**, wherein the fuel conduit comprises:

a liquid-phase charging pipe having an upper end connected to the fuel charging unit and a lower end extended to a bottom of the LPG container; and

a suction conduit that is connected to the liquid-phase charging pipe and transports the fuel to the fuel pump.

3. The LPG storage apparatus according to claim **2**, wherein the liquid-phase charging pipe is made of a flexible material.

4. The LPG storage apparatus according to claim **2**, wherein the liquid-phase charging pipe is a plastic tube.

5. The LPG storage apparatus according to claim **2**, wherein the first check valve and the second check valve are formed on the suction conduit.

6. The LPG storage apparatus according to claim **5**, wherein the first check valve and the second check valve are formed on a downstream side of the suction conduit.

7. The LPG storage apparatus according to claim **1**, wherein an injection hole is formed on the upper end of the fuel conduit such that a part of the fuel that flows through the fuel conduit evaporates to a gas phase, in accordance with a ratio determined when charging the fuel, and the evaporated fuel flows to a gas-phase side V of the LPG container.

8. The LPG storage apparatus according to claim **1**, wherein the first check valve has an umbrella shape.

9. The LPG storage apparatus according to claim 1, wherein the first check valve is opened while a vehicle is driven and the fuel inflows into the fuel pump therethrough.

10. The LPG storage apparatus according to claim 1, wherein the second check valve is opened to charge a liquid-phase side L of the LPG container with the fuel when a pressure generated in the fuel conduit is a set pressure or more when charging the fuel.

11. The LPG storage apparatus according to claim 1, wherein a quick connector is formed on the upper end of the fuel conduit to facilitate assembly of the fuel conduit and the fuel charging unit.

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